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MANPRINT FINDINGS FROM THE INVESTIGATIVE OPERATIONAL ASSESSMENT OF THE JOINT TACTICAL INFORMATION DISTRIBUTION SYSTEM
(Contract MDA903-83-C-0033)

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JTIDS INVESTIGATIVE OPERATIONAL ASSESSMENT
MANPRINT REPORT

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INTRODUCTION

System Description

The Joint Tactical Information Display System (JTIDS) is a multiservice acquisition program being led by the US Air Force. JTIDS is designed to provide secure transmission of position, target track, and voice data between host terminals in a manner that is transparent to the user. The user or host terminal is any system which orignates or receives digitized tactical information transmitted over the JTIDS secure radio links. The system was originially designed to provide communication between F-15 and Advance Warning and Control System (AWACS) aircraft and Combat Reporting Centers (CRC). The US Army recognized the potential for improved communication between Air Force and Army Air Defense Artillary (ADA) units, and within ADA units, and became part of the program well into the development process. The Army host terminals were to be TSQ-73s at the brigade and battalion levels for the HAWK fire units, the Platoon Command Post (PCP) at the batteries, and the PATRIOT missile system.

There are a number of different configurations of JTIDS, designated classes. The Class 1 terminal is currently used in the Air Force CRCs and the AWACS; it is also being fielded to some of the ADA Brigade level units. The current system under test is the Class 2 Terminal, composed of several equipments housed in an S250 Shelter. This was to be fielded at all levels for certain of the ADA units. The current objective system for the Army is the Class 2M, which will be a single hardware component that will be integrated into the host terminal's (e.g., TSQ-73, PCP, and PATRIOT) shelter.

The Army Class 2 Terminal equipment, housed in the S250 shelter, consists of the following major units:

a. Indicator Control (IC) - The IC is the control and display panel for JTIDS. It is used for data input, data output, and fault isolation.

b. Radio Receiver-Transmitter (RT) - The RT provides the transmission and reception of data between the various JTIDS terminals.

c. Digital Data Group Processor (DDGP) - The DDGP is composed of the Digital Data Processor (DDP) and the Interface Unit (IU). The IU is used for encoding/decoding data messages, while the DDP is used for Built in Tests (BIT), signal conditioning, and interface between the host and the other JTIDS equipments.

d. Host Interface Unit (HIU) - The HIU provides the interface between the host system (e.g., TSQ-73 etc.) and the JTIDS system.

This interface consists of translation of the host data communications protocol to the JTIDS data communications protocol, and vice versa.

e. Keyer Control Panel (KCP) - The KCP provides the capability for entering crypto variables.

The JTIDS S250 shelter is deployed near the host terminal. Figure 1. JTIDS S250 Configuration, illustrates the layout of the equipment. The two systems are interconnected via cable connection panels on the exterior of each shelter. Connections are made for voice communication between the JTIDS and host system operators to facilitate normal operation and troubleshooting/maintenance activities. In addition, host system to JTIDS and JTIDS to host system data cable connections are made to provide host to host communication over the JTIDS radio links.

Test Planning

Originally, the JTIDS test and evaluation was to be a full scale Independent Operational Test and Evaluation (IOT&E), executed jointly with the Air Force. The test site was to be Eglin Air Force Base, Florida and was to include the 11th ADA Brigade, with the 165th Battalion and two HAWK fire platoons. This was to include two (2) TSQ-73s and two (2) HAWK PCPs.

During Army developmental testing, a number of problems were discovered in the Class 2 Terminal. The nature and significance of these problems led the Army Program Manager's Office and the TRADOC System Manager to not certify the terminal for transition to operational test. Given that the Class 2 was not the objective system, the main reason for army operational testing became moot.

Since the multiservice testing between the Air Force and the Army was particularly important for the Air Force, the Army decided to support the Air Force to the minimal extent possible. This included the use of only a single TSQ-73 and a single HAWK PCP, with four relays and minimal manning by the 11th ADA. The Army's portion of the test was downgraded to an Investigative Operational Assessment (IOA), lasting eight weeks.

The intent of this IOA was to ensure that the Army Class 2 terminals stayed operational during the multiservice trials, using every means at hand including maintenance personnel drawn from DT. Data collection was to be minimal, with low reliability due to the few trials and limited system operating time. The data collected was to be used to provide insights into the adequacy of the design of the Class 2 Terminal from the Army's perspective, and to provide input into the design of the Class 2M Terminal. One of the areas being explored during the IOA was MANPRINT. The IOA took place between February 1987 and April 1987. This report documents the results of that IOA for MANPRINT.

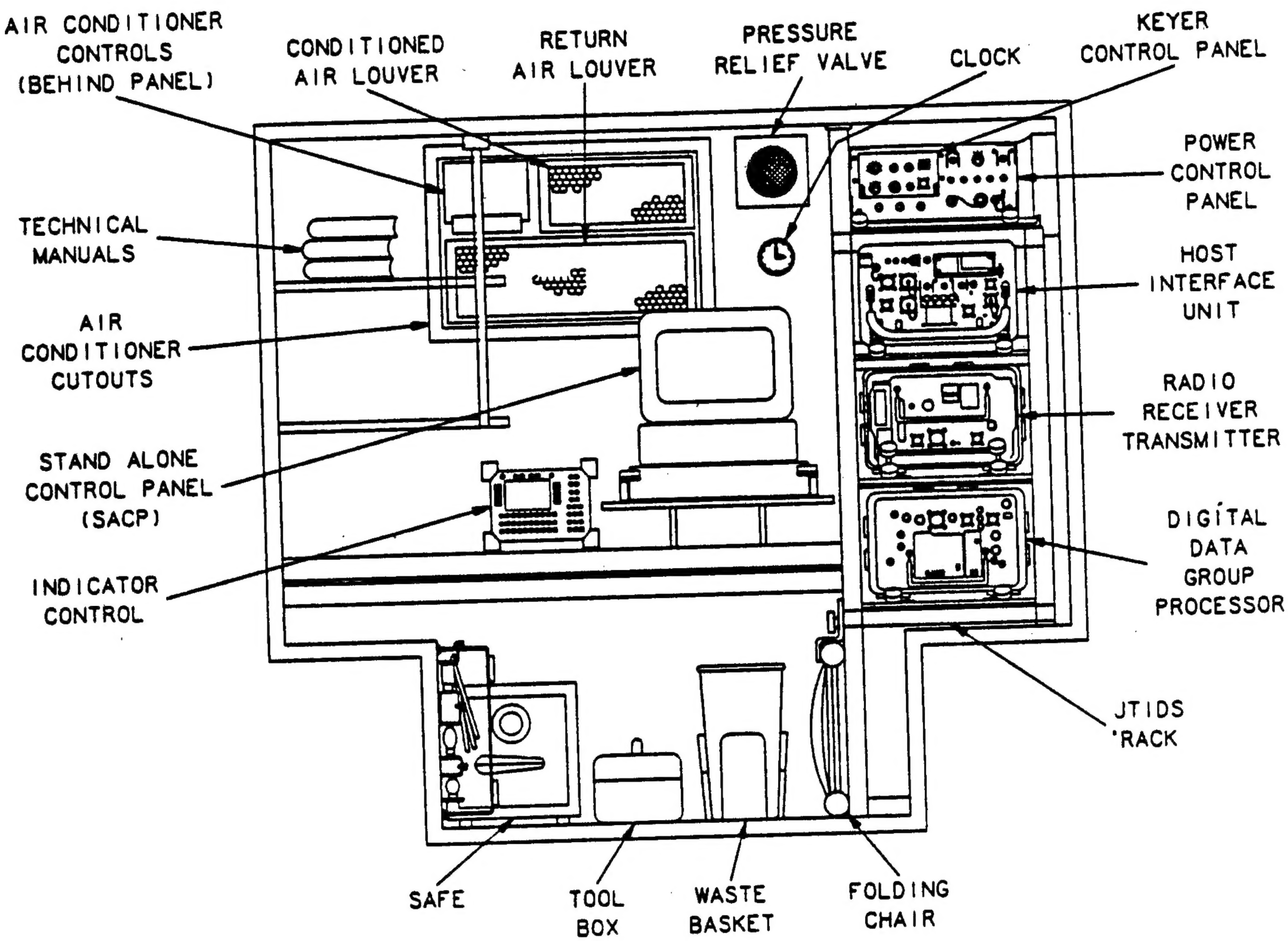

Figure 1: JTIDS S250 Shelter Configuration

Test Objectives The objectives of this IOA for MANPRINT were to provide, to the degree possible, insights on how well the JTIDS Class 2 Terminal met the requirements of the MANPRINT program. The specific domains of MANPRINT that were assessed during the IOA included personnel, training, human factors engineering (HFE), and system safety. Manpower could not be assessed given the limited 11th ADA unit resources available for the IOA, and health hazards had been assessed by developmental testing.

Test Limitations Given the downscaling of the original USAOTEA test plans to an IOA and the manner in which the test was conducted, data collection and analysis were limited as discussed below.

The size of the player pool was small (n = 8 for operator, n = 2 for net managers, and n = 2 for maintainers), lowering statistical validity, increasing the risk of a nonstratified sample of personnel characteristics, and limiting the generalizability of the data to the population as a whole.

The small number of trials that were conducted lowered the statistical reliabilty of the data, leading to unknown validity.

The maintenance objective of the IOA was to ensure that the terminals stayed operational during the multiservice trials. This was achieved using whatever means were at hand. This practice introduced uncontrollable confounds into the maintainability data and interfered with the collection of the human factors data.

SECTION II
ISSUES AND CRITERIA

There were only three basic issues for this IOA. Each is described below, along with the criteria and how they were measured.

Issue 1

The JTIDS Class 2 Terminal shall be designed to insure that personnel representing the full range of capabilities of the designated MOSs for operators and maintainers have the necessary skills and aptitudes to be trained to perform their required critical tasks to the expected level of proficiency in a field environment.

This issue combined the MANPRINT domains of personnel and training due to their close interrelationship. The complexity of a system's operation or maintenance should not exceed the capabilities of the personnel in the designated operator and maintainer MOSs to perform the expected tasks or to be trained to perform these tasks.

Criterion 1

Initialization, reinitialization, and other operational procedures shall be simple enough to ensure that personnel of the expected MOS levels and mental capabilities can learn, retain, and perform them given standard Army training methods.

The measurement methods were as follows:

a. Demographic data to include duty MOS, time in duty MOS, years in service, years of civilian education, and years of experience in communications, electronics, and computers. The demographic data was collected using a pre-training questionaire, presented in Appendix A.

b. Observations by the human factors engineers and test directorate personnel.

1) Personnel/training problems observed or identified

2) Corrective actions recommended

c. Comments from operators, maintainers, data collectors, and test directorate personnel elicited during interviews.

1) Personnel/training problems observed or identified

2) Corrective actions recommended

d. MANPRINT training assessment

1) Adequacy of training materials

2) Adequacy of manuals

3) Posttraining proficiency scores and ratings

e. Performance times and errors for initialization measured while the operators were wearing normal clothing, cold weather gloves, and MOPP IV gear. The measurement instrument was the initialization test presented in Appendix B.

Issue 2

Does JTIDS Class 2 terminal incorporate human factors design principles for ease in operation and maintenance? This issue reflects the HFE concerns of MANPRINT. The following critieria were used to determine satisfaction of the issue.

Criterion 1

The properly trained operator or maintainer must be able to:

a. Initialize the JTIDS Class 2 terminal and any associated host interface with its required long-term data within 2 hours without error.

b. Place into operation or change initialization variables of a completely installed terminal and associated host interface, that has been previously loaded with its long-term data, in less than 3 minutes. This includes loading of required crypto variables.

The measurement methods were as follows:

a. Performance times and errors measured while the operators were wearing normal clothing. These measures were taken when the operators were performing regular operational procedures.

1) HFE problems observed or identified

2) Corrective actions recommended

b. Observations and comments from the human factors engineer, data collector, player, and test directorate personnel.

1) HFE problems observed or identified

2) Corrective actions recommended

Criterion 2

The JTIDS Class 2 terminal hardware and software shall be designed to facilitate operator task performance.

The measurement methods were as follows:

a. Observations from the human factors engineer, test directorate, and data collectors.

1) Adequacy of controls and labeling (size, shape, location, appropriateness, etc.)

2) Adequacy of displays (luminance contrast, location, brightness, character design, etc.)

3) Adequacy of software (data display, interactive control, system response time, feedback, use of prompts, etc.)

4) Adequacy of workspace (dimensions, lighting, noise, accessability, etc.)

5) Adequacy of operational procedures (complexity, logicalness of steps, number of keystrokes, etc.)

b. Comments from operators, maintainers, and data collectors obtained during interviews.

1) Adequacy of controls and labeling (size, shape, location, appropriateness, etc.)

2) Adequacy of displays (luminance contrast, location, brightness, character design, etc.)

3) Adequacy of software (data display, interactive control, system response time, feedback, use of prompts, etc.)

4) Adequacy of workspace (dimensions, lighting, noise, accessability, etc.)

5) Adequacy of operational procedures (complexity, logicalness of steps, number of keystrokes, etc.)

Criterion 3

The net planner shall be able to perform the necessary planning and to develop the initialization sequences for those nets for which he is responsible without error and within four (4) hours ninety-eight per cent (98%) of the time.

The measurement methods were as follows:

a. Time and errors measured during the development of network plans.

1) Time and date

2) Elapsed time

3) Number of errors

b. Observations from the human factors engineer and test directorate personnel.

1) HFE problems observed or identified

2) Corrective actions recommended

c. Comments from net planning and test directorate personnel elicited during interviews.

1) HFE problems observed or identified

2) Corrective actions recommended

<u>Criterion 4</u>

The system shall be designed so that personnel of the expected MOS levels at Operational Support, Direct Support, and General Support maintenance activities can easily perform necessary maintenance tasks. The JTIDS class 2 terminals shall be repairable within 0.25 manhours seventy five percent (75%) of the time.

The measurement methods were as follows:

a. Observations by the human factors engineer regarding the maintainability of the JTIDS Class 2 terminal.

1) HFE problems observed or identified

2) Corrective actions recommended

b. Comments and data from the RAM data base regarding the causes of system failure, the length of time the system was unavailable, and the causes for the length of time unavailable for those incidents attributable to human error.

1) Maintainer name and SSN for each maintenace action.

2) Terminal ID number

3) Incident descriptions

4) Manhours required to repair each incident

5) Total number of incidents requiring repair

6) Percentage of incidents repaired within 0.25 manhours

c. Observations and comments from operators, maintainers, data collectors, and test directorate personnel elicited during interviews.

1) HFE problems observed or identified

2) Corrective actions recommended

Issue 3

Is the JTIDS Class 2 terminal designed to be operated and maintained without risk of personnel injury? This issue reflects the MANRPINT domain of safety.

Criterion 1

The soldier must be able to operate, maintain, and deploy the JTIDS Class 2 terminal without danger of personal injury.

The measurement methods were as follows:

a. Observations from the human factors engineers regarding safety.

b. Comments from the operators, maintainers, test directorate, and data collectors elicited during interviews.

1) Safety problems

2) Corrective actions recommended

c. Reported incidents of injury due to electric shock, sharp edges, or other physical trauma.

SECTION III
INSTRUMENTS AND PROCEDURES

General

Data for MANPRINT was collected using three basic techniques:

a. Observation
b. Interview/questionnaire
c. Performance data collection

Observation

Observation consisted of experienced HFE personnel watching the operator/maintainer during the performance of typical tasks. If any difficulties in task performance were observed, the HFE personnel elicited information through the collection of comment data. Comment data was collected by immediate or delayed informal unstruc- tured interviews.

Interview/questionnaire

These consisted of formal structured interviews or questionnaires administered to player, data collector, and test directorate personnel in a controlled setting. The items dealt with the operability and maintainability of the system, and with MANPRINT issues such as training, manpower, and personnel.

Performance Data

Performance data collection consisted of collecting objective data on how well a task or tasks were performed. For this data the main types of performance measures were time to perform and errors during performance.

Data Collection Procedures

Data collection for the JTIDS IOA was performed in three phases:

a. Training assessment
b. Multiservice testing
c. Side tests

The multiservice testing and side tests were concurrent.

Training Assessment.

The training for the IOA consisted of two distinct types. The first was operator and maintainer training and the second was net manager training. Operator and maintainer training was conducted from 2 February 1987 to 20 February 1987. Net Manager training was

conducted from 26 January 1987 to 13 February 1987. Both were conducted at Fort Bliss, Texas.

Operator and Maintainer Training Assessment. This assessment used four types of measurements:

a. Pre-training questionnaire - All personnel selected for player training were given a pre-training questionnaire to collect demographic data on the operators and maintainers. In addition, AFQT and AREA Aptitude (AA) scores were collected for each of the player personnel.

b. Post-training test - A post-training test was given at the conclusion of the formal JTIDS training. The post-test consisted of 45 multiple choice questions and took approximately 45 minutes to administer. This test assessed operations and maintenance tasks, and the trainees understanding of the concepts underlying the operation and maintenance of the JTIDS Class 2 Terminal.

c. Performance observation - In addition to the formal tests, HFE personnel observed the player personnel during the multiservice testing. The emphasis of the observations was to identify any player performance difficulties that were attributable to training shortfalls.

d. Technical manual evaluations - The technical manuals were reviewed to assess their readability and format for information transfer. The reading level of each of the technical manuals was also assessed to ensure that they did not exceed the capability of the users to comprehend the written material. This assessment was performed using a personal computer program called RIGHTWRITER. Several representative pages of each manual were typed into the program to determine the overall reading level.

Net Manager Training Assessment. Training for NET Managers was multi-faceted. The management process involves identifying the participants and their information transmission requirements. From this, a set of information transmission blocks is allocated and each user is assigned a set of transmission time slots. The communications security needs are determined and parameters for the network are developed. Finally, various master parameters are determined along with the equipment initialization parameters. This whole process makes up the job of the Network Manager who developes a network plan.

There is almost never a single/unique correct network plan for a set of network participants. Different personnel can develop plans that are different and yet each will satisfy the operational network communications requirements. To assess the adequacy of training for the net managers, a part-task approach was used. The segments of the assessment instrument were as follows:

a. Participants list

b. Multi-Net Connectivity Worksheet

c. Single & Multi-Net Time Slot Map

d. COMSEC Parameter Checklist

e. Network Parameter Checklist

f. ASIT Master Parameters

g. HIU Master Parameters

h. Class 1 Initialization Worksheets

i. Army Working Parameters

j. Time Slot Initialization Parameters

At the end of training, the graduates were tested on all tasks except the two tasks establishing the initialization input data (i.e., h and j above). They worked each segment in sequence and each was reviewed for completeness and use of the forms. Total performace time was recorded.

Multiservice Testing

The JTIDS Class 2 Terminal multiservice testing consisted of the Army ADA units of one Master Battalion (MBOC) and one HAWK Fire Platoon creating a missile engagement zone (MEZ) for supporting simulated Air Force air-air combat missions. In addition, the Army elements provided simulated base defense missions before and after the multiservice missions. The principal effort was to support the Air Force operational test while collecting as much Army specific data as possible in the process. The data collection procedures used during this test phase are described below:

Observation Data. Observation data was collected throughout the multiservice testing. HFE personnel observed Army JTIDS player personnel during the trials to identify any human performance problems that existed. Observations focused on those trials with the most potential for human performance problems. Observations and comment data were compiled in notebooks continuously during the testing. These records described the nature of each problem, the trial in which it was observed, any comments from the player personnel regarding the problem, and observed effects on human and system performance.

Performance Data. Performance data in the form of time and errors were collected during the following operations, to the extent possible:

a. Initialization of JTIDS and host terminals

b. Place into operation or update initialization variables, on a completely installed terminal

c. Fault diagnosis and repair

d. JGRAM message handling (JGRAM messages were not routinely used, so no data was available)

Manual initialization was also explored in a side test discussed below. RAM data forms were reviewed to determine the time required for the performance of maintenance tasks.

Interview Data. Structured interviews were administered to players and unstructured interviews were administered to test directorate, data collector, and HAWK personnel at the end of multiservice testing. These interviews elicited opinions regarding the operability and maintainability of the JTIDS Class 2 Terminal. The items included in the interview addressed potential HFE and safety problems identified during the pilot and multiservice testing.

Safety Data. Safety data consisted of HF engineer identified potential safety hazards. There were no safety incidents during the testing period. Other data consisted of informal interview opinions from player personnel.

Side-Tests

During the multiservice testing, two Army specific side-tests were accomplished, manual initialization and network planning.

Manual Initialization. During periods when multiservice testing was not being conducted, data was collected on manual initial- ization of the terminals. Operators were given pre-prepared initial- ization sequences to enter into the terminal. The HFE personnel observed the operators, using the Manual Initialization checklist, and made notes of any errors committed. Performance times were collected. Data was collected on all operators wearing normal uniforms, cold weather gloves, and NBC gloves and mask.

Net Management Planning. The objective of this side test was to assess network planning through generation of initialization sequences under field conditions in a multiservice environment using Army and Air Force net managers. During the multiservice testing, there were only two Army and two Air Force trained net managers. These net managers developed network plans and initialization sequences based on information provided to them by the test controllers.

During the test, HFE personnel observed the net managers performing their tasks and made notes of any performance difficulties. The net

managers were interviewed at the conclusion of the exercise to elicit their comments and to explore the noted performance problems. Performance time data was collected and the network plans were submitted to MITRE Corporation for adequacy scoring. It was not possible to use the planned network initialization data during multiservice testing.

SECTION IV
ANALYSIS AND RESULTS

Personnel and Training (IOA Issue 1.)

Operators

Operator Demographics. There were eight JTIDS Operators involved in the IOA. The characteristics of each operator are presented in Table 1. JTIDS Operator Demographic Data. The operators ranged in age

TABLE 1. JTIDS Operator Demographic Data

	OPERATORS							
CHARACTERISTIC	1	2	3	4	5	6	7	8
Height(in)	71	69	64	75	70	76	70	68
Weight(lbs)	198	155	135	240	175	195	172	140
Age(yrs)	24.5	20.3	38.0	25.5	30.0	21.2	27.5	20.5
Grade/Rank	E4	E4	E6	E5	E4	E4	E5	E4
Months Service	27	29	120	77	52	30	114	30
MOS	16E	16E	25L	25L	31K	31K	31K	31K
Months in MOS	27	29	84	5	52	30	114	30
Weeks in JTIDS	2	2	0	0	0	1	2	0
Civ Educ.(yrs)	12	12	16	12	12	12	12	12
AFQT Score	68	64	92	43	66	30	18	39
%ile of MOS(AFQT)	72	66	94	26	61	11	4	19
GT Score	120	109	125	109	109	84	96	94
%ile of MOS(GT)	85	62	89	51	79	18	47	41

from 21 to 38 years, held the rank of E4 through E6, and were from three different MOS groups. All but one had been in their MOS more than two years. A summary of these characteris- tics is presented in Table 2. JTIDS Operator Demographic Summary. Their average AFQT score

TABLE 2. JTIDS Operator Demographic Summary

CHARACTERISTIC	MEAN	sd
Height(in)	70.4	3.57
Weight(lbs)	176.3	32.36
Age(yrs)	25.9	5.60
Grade/Rank	E4	NA
Service Time(mo)	59.9	36.60
Time in MOS(mo)	46.4	33.44
Time - JTIDS(wks)	0.9	0.93
Civ Educ.(yrs)	12.5	1.32
AFQT Score	52.5	22.59
%ile of MOS(AFQT)	44.1	NA
GT Score	105.8	12.80
%ile of MOS(GT)	59.0	NA

was 52.5, slightly below the 50 %ile for their respective MOS groups and their average GT score was 105.8, slightly above the 50 %ile for their MOS groups. This was probably as good a sample of expected JTIDS operators as could be obtained for test purposes without a great deal of added effort in their selection.

Operator Training. Operator training consisted of 80 hours of training at Fort Bliss, TX. The training consisted of instruction and practice in the operation of the JTIDS equipment as installed in the S250 truck mounted shelters used during the IOA. The course was that prescribed by TRADOC and was taught by instructors from Fort Gordon, GA. All trainees passed all course tests and completed the prescribed hands-on exercises during the training.

At the completion of training, all operators were given a written multiple choice test on the nature and operation of the JTIDS. In addition, the instructors as a group were asked to rank order the students as to their expected capabilities to perform the JTIDS operator tasks. The results of the instructor ratings and the written test are presented in Table 3. Operator Training Outcomes. The table

Table 3. Operator Training Outcomes

OPERATOR	PRIMARY MOS	AFQT SCORE	%ile of MOS	POSTTRNG SCORE (% RIGHT)	TRAINER RATING
1	16E	68	72	51	4
2	16E	64	66	64	2
3	25L	92	94	53	7
4	25L	43	26	51	8
5	31K	66	61	69	6
6	31K	30	11	51	3
7	31K	18	4	58	5
8	31K	39	19	51	1

suggests that the individuals used in the assessment were not atypical of soldiers since the range of AFQT scores was from 18 to 94 and included 30s, 40s, and 60s. No MOS group had any consistent advantage in terms of the Post Training Test or the Trainer Ratings. There was no clear advantage to one or the other of the represented MOSs during operator training. Therefore, based on the IOA training experience, the three MOS groups (16E, 25L, or 31K) seem to be adequate for the JTIDS Operator position.

One problem with the training was course content omissions because of the limited time for administration. Since the maintenance concept required the operators to be the direct support maintenance personnel, omissions in course content covering the localization of faults that caused failures in communication between the Master Battalion(MBN) and the Assault Fire Platoon(AFP) were a problem. The faults were in the

interface between the JTIDS and the host computers and over the radio links between the JTIDS terminals. Each piece of JTIDS terminal equipment could be working properly and the communica- tion would still not be accomplished. The operator training did not include tasks for fault isolation beyound the JTIDS shelter. The fault isolation tasks involved in locating a problem in a network interfacing computers over radio links are not exhausted by checking the terminal equipment without getting any information about the interface. The operators were not trained in tasks for troubleshooting interface problems.

The course content for interface troubleshooting would not be concerned with any single piece of JTIDS equipment; however, it would still involve some of the principal operator job skills. This area of problems points out a major oversight in the concept of New Equipment Training (NET), that is, NET is equipment oriented instead of job task oriented. It is possible to do a very good job of teaching the new equipment and have the trainee come away with almost no ability to do the job tasks, because they are not equipment specific.

It seems apparent that two weeks training is insufficient for the JTIDS operator to reach competency without extended field experience. Training host operators to be JTIDS operators was not addressed in the IOA and may in fact provide some saving in training time due to experience with the host system, something the JTIDS IOA operators did not have; even though they were ADA personnel, they were not host operators.

In general, the training materials were adequate in terms of usability and clarity, based on the trainees comments. The principal problem mentioned by the trainees was the availability of equipment for job task practice.

Class size/Equipment availability. The class in which the eight operators and two GS maintainers were trained, consisted of 22 students. The class had five JTIDS shelters available for use, with one shelter non-functional because of equipment problems. Since the students could only work in the shelters in pairs, some were working while others were waiting. In addition, when pressed for time only one of the students got to perform a specific task while the other observed or read the procedure from the manual. This approach familiarizes the students with the tasks but does not produce graduates with great competency in job skills.

Recommended Solution. Class size should be reduced in order to provide adequate time on the equipment for each student to develop competency in the necessary job skills. If class size cannot be economically reduced, then staggered entry of one day could be used for half the class. This would require that two instructors be used for each class so that half the class could be in the classroom while the other half could be in the shelters. The class halves would rotate each day, providing one day in the shelters and the next in the

classroom. In either case, the number of students in a class section should be no more than two times the number of shelters available for task practice.

Maintainers

Maintainer Demographics. There were two maintainers used during the JTIDS IOA. The characteristics of each maintainer are presented in Table 4. JTIDS Maintainer Demographic Data. One of the maintainers was a 35L and the other was a 33P; however, both were E4 and both had completed high school. The summary of their characteristics is presented in Table 5. JTIDS Maintainer Demographic Summary. Their average AFQT score was 57.5 and their average GT score was 101.5.

TABLE 4. JTIDS Maintainer Demographic Data

	MAINTAINERS	
CHARACTERISTIC	1	2
Height(inches)	71	71
Weight(lbs)	155	147
Age(yrs)	24.2	19.8
Grade/Rank	E4	E4
Service Time(months)	66	18
MOS	35L	33P
Time in MOS(months)	66	5
Time with JTIDS(wks)	28	60
Civ Education(years)	14	12
%ile of MOS (AFQT)	16	59
GT Score	86	117
%ile of MOS(GT)	7	46

TABLE 5. JTIDS Maintainer Demographic Summary

CHARACTERISTIC	MEAN
Height(inches)	71.0
Weight(lbs)	151.0
Age(yrs)	22.0
Grade/Rank	0.0
Service Time(months)	42.0
Time in MOS(months)	35.5
Time with JTIDS(wks)	44.0
Civ Education(years)	13.0
AFQT Score	57.5
GT Score	101.5
%ile of MOS(GT)	26.5

Although neither their AFQT or GT scores was high in the %ile ranking for their respective MOSs, both seemed competent during training and on the job.

Maintainer Training. The maintainers received 120 hours of instruction on the JTIDS. The first 80 hours was the same as the operator training, 40 hours additional training was given after the conclusion of the operator course. The additional instruction emphasized chassis and card removal and replacement, as well as, troubleshooting. At the conclusion of the maintainer training, the post-training test was given to the maintainers. The outcomes are presented in Table 6. Maintainer Training Outcomes. Although the maintainers AFQT and GT scores were similar to the operators, their post-training test scores were somewhat higher. It seems that the maintainers were somewhat more knowledgable about the JTIDS at the conclusion of their training with the additional 40 hours of instruction and practice.

Table 6. Maintainer Training Outcomes

MAINTAINER	PRIMARY MOS	AFQT SCORE	%ile of MOS	POSTTRNG SCORE (% RIGHT)
1	35L	34	16	71
2	33P	81	59	67

Observation of the maintainers during the IOA suggests that the content of the training was relevant to their jobs and that it was placed at the right level. It was clear that the graduates were able to run the available diagnostic tests and use the technical orders adequately for the jobs assigned during the IOA. Since no military personnel performed the whole maintenance job, it is not possible to draw any conclusions about the adequacy of the training for the total set of JTIDS maintenance tasks. Problems observed during maintenance are detailed later in this section; however, the biggest problems overall were the job performance aids (i.e., the technical manuals and the diagnostic procedures).

Adequacy of manuals. The reading level for the technical manuals is somewhat higher than desired. The average reading level for free text and tables in the manuals is about 10th grade level, with 9th grade being desired. Although the required reading level of the manuals is high, learning the vocabulary of the specialist will effectively reduce the apparent reading difficulty. Therefore no change to the reading level is recommended. Other problems with the manuals are discussed under the maintenance heading below.

Net Managers

Net Manager Demographics. Demographic data was not collected for the two Net Managers assigned to the IOA. However they seemed adequate during training and during the IOA testing discussed below.

Net Manager Training. Net Manager training was two weeks and two days in length and was presented just prior to the start of IOA. The course was taught by experienced Net Manager training personnel from Ft. Gordon, GA. The course focus was on net planning of Army resources and covered all planning forms up to and including terminal initialization parameters. Both IOA Net Managers completed the course satisfactorily, including the final exercise.

At the completion of training, a problem was given to the Net Managers which involved the resources to be used at Eglin AFB, FL. The solution required the completion of a net plan through the working parameters but did not require the development of initialization parameters. All forms were completed and all required entries were made on each form. All participants were included and each was provided the needed time slots for the type of information to be handled. The training provided at least a minimum background for both the cognitive skills of organizing a network and the clerical skills of using the Army forms. Apparently the personnel assigned to the training were capable of learning the Net Manager skills, at the novice level, through the available course.

HFE for Operation and Maintenance (IOA Issue 2.)

Terminal Deployment

Actual set-up immediately following a move occurred every day for the relays. In general, the required activities after arriving on site included the following:

1. Spot and ground the JTIDS van
2. Spot and ground the generators
3. Connect JTIDS power and antenna
4. Connect host interface cable (HAWK) (at MBN and AFP - not JTIDS relays)
5. Turn on JTIDS system equipment

These activities required 20-30 minutes to complete, given no equipment or cabling problems. This did not include attaching interconnecting cables between the JTIDS components.

Antenna set-up was performed only occasionally, when it was necessary to relocate an antenna. When performed, this activity took 45 - 60 minutes depending on the level of proficiency and practice of the individuals assigned to the activity and the nature of the antenna site.

Location of Connector Panel. The principal problem was the height above the ground of the antenna, host interface, and field phone connectors on the vehicle mounted shelter. Soldiers over 6 feet tall could reach the connectors with only minor difficulty, anyone shorter had to stand on the truck tail gate and reach around the side of the shelter to connect the cables. The average height of the operators was five feet ten inches, so almost all of them had problems with these connections. Making the connections was a one-hand job since the other hand had to be used to hold on, so as not to fall off the tail gate. On several occasions, antenna connection problems caused the equipment to function improperly.

Recommended Solution. The connection panel for the antennas, field phone, and the 26 pair cables should be moved down to mid- shelter. This should facilitate cable connections for a truck mounted shelter and one placed on the ground. Moving the panel below mid- shelter would make cable connections difficult for a shelter placed on the ground.

Initialization

The required activities after completing deployment included the following:

1. Load crypto variables
2. Initialize JTIDS equipment
3. Coordinate net participants
4. Enter net ready to pass traffic

These activities required approximately 35 - 45 minutes when using the rapid load available with the IOA equipment configuration. When performed using the ICP manual initialization scenario, these actions took about 50 - 60 minutes. These times are representative given no equipment or operator problems. Problems frequently extended the time to two - three hours. Average times for manually initializing JTIDS equipment (2. above) are presented in Table 4.2.1.2.1. Specific problems associated with initialization are discussed below.

Table 7 ~~4.2.1.2.1~~ JTIDS Manual Initialization Times (minutes)

	Aver. Time	Time S.D.
Field Live level 0	30.6	16.5
MOPP Level 0	18.8	1.9*
Cold Weather Gloves	19.0	3.2*
NBC Gloves and Mask	19.7	2.1*

* The procedure for these measurements required the initialization of 10 slot blocks - a relay. Procedures for the AFP and MBN were 50% - 150% longer.

Loose Connector. The connector for loading the crypto variables on the Digital Data Group Processor was prone to coming loose if not used

carefully. If the crypto load device was put on the connector tightly (a likely occurrence with gloves which mask tactile sensations), the connector would loosen when removing the load device. Once loose, this connector would spin in its mounting hole and subsequent loading of variables was next to impossible because the load device could not be attached to the connector.

Recommended Solution. This connector should use a D-shaped mounting hole. Even if the backing nut loosened the connector would not be able to spin in its mounting hole.

Loss of Initialization Variables. Initializing the terminal was fairly routine except when variable values would be dropped or changed by the JTIDS equipment for no apparent reason. In some cases, there was no indication that the values had changed until a confirmation check of the values was performed by the operator. This was frequently not done unless the operator believed there was a problem. In most cases, reentering the variable values which had changed was all that was required to clear the problem. In other cases, there was an actual system failure and some form of troubleshooting was required (e.g., use of BIT). The variables most frequently involved were those in the HIU referring to host type and message packing. During the IOA This problem occurred approximately every other day.

Recommended Solution. A Standard Operating Procedure (SOP) for verifying variable values after initialization would prevent attempts at operation when the variables had changed. A better solution would be to identify and correct the cause of the value changes.

Design of ICP Keyboard. Entering alpha information on the keyboard was difficult for two reasons. First, the arrangement of the alpha keys is different than that of any other keyboard in use by operator personnel; this produces errors in both initialization value entries and in J-gram messages. Errors in key localization were observed daily even after eight weeks of equipment usage. This problem will not go away, because QWERTY keyboards are used daily by operators. Second, the size and actuating pressure of the "keys" makes entry difficult and error prone even without gloves, this problem gets worse with gloves. On at least one occasion two keypads were observed to come loose, causing the keys to operate erratically.

Recommended Solution. The standard QWERTY keyboard layout should be used on the JTIDS keyboard so the operators will have common keyboards to use for text and data entry, regardless of which system they are operating. The alpha and numeric key pads should be larger and farther apart to accommodate the use of gloves by the operator. Since the loose keypads were observed on only one occasion, it is hard to determine if this was an isolated case or a general problem.

Protocol for Net Startup. Coordination of NET participants was more of a chore than first anticipated. Coordination of all participants is accomplished by synchronizing the clocks of all other terminals in the

network to the clock of the terminal identified as the Net Time Reference (NTR). This is done automatically by the terminals. It turned out that the NTR had to be leading all other stations in terms of clock time. If the NTR was lagging a station attempting to enter the NET, that station took a long time to enter the NET and sometime never entered. This fact was learned only after the operators had several failed entry attempts. In addition, there can be only one NTR or more than one NET may be created. There were no procedures for determining whether there was more than one NTR for a given NET or for returning to one NTR if more than one existed.

Multi-service note -
This was a particularly knotty problem when there was an Air Force Net and an Army Net operating simultaneously prior to creation of the multiservice Net. It appears this problem could get worse if the multiservice participants are NTR in the non-multiservice portion of their initialization and are not NTR in the multiservice portion of their initialization. Someone needs to identify how the operators are to determine that there are NTR problems and what should be done when these problems are found. This is not a doctrine problem but a procedure development problem! Special attention must be given to the time when there is no communication among the participants because the NET is not established.

Recommended Solution. First, develop a SOP for ensuring that there is only one station with the NTR designation in the NET. Second, either develop a SOP to ensure that the NTR clock is leading all other participant stations or make certain that the terminal hardware and software can synchronize forward as well as it does backward.

Strength of Radio Signals. Entering the net becomes a problem when the station attempting to enter has a marginal radio signal between itself and the station(s) with which it should be communicating. Principally, there is no way for the operator to tell whether the signal is there or not, the display simply says NO SYNC; it does not say why there is no sync. The operator can only check the terminal's initialization values and if they are correct no other information is available for further diagnosis. All that can be done is to keep sending the terminals signal over the air waves and hope another terminal receives it and provides the net entry assistance.

Recommended Solution. An indicator of received signal strength should be provided; either as an alert message or an indicator on the front of the R/T. There is no point in attempting to enter a net if insufficient radio signals are being received. An analog indication is preferred because a judgment of likelihood of success can be learned for various levels of received signal. In addition to this indicator, a means of communication among the JTIDS stations, other than the JTIDS terminals, needs to be provided. Had a back-up means of communication not been available during the IOA, it is doubtful that the assessment would have been completed or that any successful nets would have been established.

Operation

There are very few tasks for the operator to perform when the terminal is operating properly after entering the net. If there had not been many malfunctions during the IOA the HAWK operators could easily have been the JTIDS operators. Periodically the operator checks on the message status of the terminal by looking at the IC alert message details, even when there are no alerts. Under the current configuration the most frequently watched alert/status was the HIU alert page. This is because the most frequent problems during operation occured between the HIU and the host equipment.

Troubleshooting of Integrated Systems. The HIU link to the host equipment provided the most difficult problems during the IOA. This also turned out to be the area of the integrated systems with the least information available for troubleshooting. Neither the host operators nor the JTIDS operators had sufficient documentation for troubleshooting the interface. In addition, neither had training in this area of system integration. Both operators (i.e., JTIDS and HAWK) had training in their system but neither had training in the interface area. When problems arose, dicussions between the operators were not only fruitless but the usage of terms for each system was different, thereby interfering with meaningful communication. For example, when the HAWK operators talked about a good link, they meant good data from the MBN to the AFP. Whereas, the JTIDS operators could have a good link when the terminals were communicating even though the data from the MBN to the AFP was not good (i.e., a needline fail existed).

Recommended Solution. First, a set of procedures for troubleshooting the JTIDS to host interface for each of the potential hosts needs to be developed and validated. The procedures need to cover the HIU to interconnecting cable, the interconnecting cable, the host modems, and the host interfacing computer ports. These procedures need to include the information requests to the host operator in terms of the displays and information available to that operator, as well as, the displays and information available to the JTIDS operator. Second, validated procedures need to be incorporated into the JTIDS operator course and practice needs to be given in using the procedures during operator training.

Messages in Error. The HIU provided one interesting condition during operation, the IC would show an alert of INIT WAIT on the screen after the net was established and traffic was being passed. When this occured everything proceeded normally although the operator had an indication that the terminal was in a wait state. This alert was not covered in any of the manuals for the condition of non-initialization activities.

Recommended Solution. Remove messages which are not appropiate to the terminal operating mode. It may be necessary to add a new message to the pool, one for "wait" states that occur during normal operation.

Operation under Electronic Counter Measures(ECM). The operators had very few choices of what to do during operation in an ECM environment, there were too few indications of the quality of signals or data. In addition, there were no operator adjustments available which might be used to combat ECM. The principal problem was that the operators could not tell what was causing a communication difficulty. They were not able to tell whether bad data was caused by a bad link or by ECM.

Recommended Solution. Provide signature key words embedded in the transmissions to aid in the determination of the quality of the data independent of the quality of the received radio signal. This should include keywords for each of the transmissions. An alternative is to use something like CRC words in the transmissions to detect the occurrence of errors.

Hardware Design

Most of the hardware design problems are related to connector placement, indicator placement, and control accessibility.

Design of ICP Keys. The ICP line select keys seem to be usable with and without gloves since few errors in line selection occured during the initialization or operating sequences. The keyboard keys were another matter. The keypads were too small and too close together, causing the wrong character to be entered even without gloves. In addition, the key actuating force was high enough to cause considerable finger discomfort when entering initialization sequences as short as those for the relay terminals.

Recommended Solution. Both problems require ICP keyboard redesign for correction.

Time for Initialization. A separate but related problem is the time required to initialize a terminal from scratch after a maintenance action has been performed or whenever a terminal needs to change its initialization because of network reconfiguration. Terminals with even modest slot block requirements, 10 to 20 slot blocks, required at least one half hour to initialize using the manual procedures. It must be possible to initialize faster than this under battle field conditions.

Recommended Solution. Battlefield time constraints suggest the need for some sort of long term off-line variable storage. The new 3 1/2" disc drives would seem to be a good choice based on storage capacity and media durability. Changing initialization parameters amounts to loading the previous parameters, changing those that need it, and saving the new parameters. It seems reasonable to retrofit a 3 1/2" drive and controller to the current ICP. With some modification to the software, the initialization variables could be saved directly to the ICP 3 1/2" disc drive. These variables could then be reloaded whenever required. All this could be done without the need for an auxiliary computer which is fairly sensitive to abuse (shock mounting developed for the auxiliary computer used in the shelters during the IOA).

Design of Digital Data Processor Group(DDPG). The principal hardware design problem for this component is the placement of the cable connections. With the exception of the outside connectors (i.e., J2, J3, & J4) it is necessary to remove one or more cables in order to remove an inside cable. With an ungloved hand, this is a fairly difficult task, with a gloved hand this task is just barely manageable.

Recommended Solution. Rotating the JTIDS mounting rack 45 degrees clockwise would help this problem immensely. The permanent cure is to rotate the rack and rearrange the connector layout on the front of the DDPG.

Location of DDPG Indicators. A second problem is the location of the BIT indicators and Reset switch. To a lesser extent, the location of the Elapsed Time indicator is also a problem. The BIT lights cannot be seen or reset by the operator without leaning over the equipment mounting rails so that the eyes are directly in front of the component. This cannot be done easily enough to ensure continuous monitoring of BIT status.

Recommended Solution. Again, rotating the mounting rack 45 degrees clockwise would correct this problem. Even rotating the rack will not make the Reset switch easy to reach and press because of the proximity of connector and cable J9. The only solution is to revise the layout of the front panel.

Layout of Receiver Transmitter (RT) Panel. The front of this component has a much cleaner layout because it has fewer cable connections. However, given the current mounting configuration, the Elapsed Time indicator, Fault lamp, and Reset switch are hidden from the operators view by cables.

Recommended Solution. Rotate the mounting rack 45 degrees clockwise.

Design of Power Control Panel (PCP). The Power Control Panel had at least one major problem and several minor problems in its design. During one maintenance problem the Terminal Power CB was found to be faulty. This switch could not be replaced by the DS maintainers except by replacing the whole PCP. For battlefield maintenance and logistics this seems like overkill in the maintenance philosophy. If a new PCP were not available a whole JTIDS terminal would be out of action because of a bad circuit breaker.

Recommended Solution. Re-plan the spares provisioning and level of maintenance activities for the battlefield environment in terms of the user units in which this equipment will be located. If the right switch was available, the HAWK unit could have replaced it and the PCP would not have had to go back to depot for repair.

Mounting of Host Interface Unit (HIU). This unit experienced the most problems during the IOA. However, the Fail lamps and reset switch

were the most easily seen and reached of all the JTIDS components. The connectors are somewhat better spaced for connecting cables than on most of the other JTIDS components. Only the J3 connector proved a problem for operators with gloved hands, because it was located between two other connectors. The power switches and circuit breakers were located between cables which made their operation difficult given the current mounting configuration. Again, the power indicator lamps were hidden from the operator's view by cables in the current mounting configuration.

Recommended Solution. Turning the mounting rack 45 degrees clockwise would help the HIU problems with the exception of J3. Moving J3 would require redesign of the HIU front panel.

Software Design

The software design, using nested menus, seemed to work reasonably well and the current implementation seemed adequate. The operators had little trouble using the menus and did not seem to get lost since they could always get back to the first menu, Pg1, and then reenter if necessary. After some field practice all operators were competent in getting alert pages on the ICP to monitor message and HIU status, the two areas giving the most information about the current state of operation.

System Interface Design

The design of the host/JTIDS interface seemed adequate in terms of system interconnection to the host and the ease of connecting the necessary cables. The main interface problem areas were in troubleshooting and fault isolation. These areas were discussed above under operator tasks.

Maintenance

Manual Referencing. The principal problem with the design of the technical manuals is that they require a large amount of skipping around from one procedure to another to get anything completed. This approach is highly error prone, since it is easy to loose track of where in the initial procedure one left off and where one should pick up when coming back. This is particularly bad when Table 1 references Table 2 which references Table 3. After Table 3 which table should be done next - Table 2 or Table 1. There is no return referencing in the tables, only outgoing referencing. Frequently one manual needs to be opened to two places at the same time. This is a MANPRINT nightmare.

Recommended Solution. Although it would require some work, a linear approach to procedure development would be desirable. Even an approach where all referencing to which table to go to next was in one manual, with the procedure tables in another, would be preferred to the present organization. It's easier to have two manuals open than to have one manual open to two places.

Manual Organization. The performance aids are not organized by the equipment or procedures being followed; its a mixture. In one case, the DDPG is split in the manual with the IU being covered in one place and the DDP being covered in another. In the case of initialization procedures there is so much duplication across manuals that it is hard to know which procedure to follow - the one in DEP 11-5820-903-12 Radio Set AN/URC-107(V)3 or the one in DEP 11-5820-929-12 Host Interface Unit J-4278/G. Some things are done in different orders in these two manuals, with no indication of whether or not this makes a difference.

Recommended solution. Organize the manuals so that the procedures for each chassis are in a single manual. Reduce the duplication and change the procedures to agree or indicate why any differences exist.

Repetition of BIT Procedures. Operator & DS Maintenance troubleshooting was performed by using BIT. GS Maintenance troubleshooting was performed by contractor (Singer) personnel and was not observed during the JTIDS IOA. For most observed problems the BIT tests seemed to work satisfactorily, with one exception.

If the outcome of the BIT was in doubt and it was repeated several times, the displayed values could not be trusted. If BIT was run more than twice, it was necessary to turn off the equipment so that the memory was cleared and then turn it back on and run BIT again. If the problem was suspected to be in the HIU there was no BIT which could test this part of the JTIDS equipment.

Recommended Solution. Revise the BIT programs to permit the use of BIT as many times as necessary without memory contamination.

Layout of Cable Connectors. Cable connections between the JTIDS equipment items were for the most part unacceptable. The cables on the PCP are large and too close together, frequently two connectors must be removed to get at the one of interest. The data cable connectors on the RT are much too close together for manipulation by a gloved hand. The same is true of the DDPG, the HIU, and the main power control panel. Even when the maintainer did not have gloves on, the cables could only be removed and reconnected in a certain order on each of the front panels. Cables on the rear of some items required the maintainer to get in very difficult working positions, this situation will undoubtedly lead to improper connections and/or damaged connectors.

Recommended Solution. If the JTIDS is to be fielded in the tested configuration serious consideration must be given to redesigning connector layout on each of the chassis front panels.

Mounting of JTIDS Chassis. Chassis removal for three of the four main components is difficult since the chassis are heavy and in awkward positions for removal and replacement, especially since they all require a two person lift. During the IOA, a single person lift was almost always observed. Several removal and replacement activities were performed during the IOA and most of these required 15 to 25

minutes to accomplish when the replacement chassis was available at the required location. The fact that these activities went quickly and without any safety incidents is a credit to the effort put forth by the operators and DS maintainers, not the quality of the design of the cabling or mounting systems.

Recommended Solution. Turn the mounting rack 45 degrees clockwise so that two people can remove/install the JTIDS chassis.

Tools and Test Equipment. Special JTIDS tool kits for the Army maintenance personnel were non-existant. It is assumed that the host organization maintenance operations will possess adequate tools to support maintenance activities on the JTIDS. The only piece of test equipment which seems to be required is a multimeter to use in checking cable continuity and voltages. Again, it is assumed that the user organizations will have at least one of these meters.

Network Planning

The two Army Net Managers were tested during the IOA in a planned side test. In this test, the two Army Net Managers worked with two Air Force Net Managers. The test consisted of having the Net Managers plan a JTIDS communication network using a limited set of resources which were available at Eglin AFB. The anticipated scoring technique was to use the planned network as the initialization basis for the resources at Eglin AFB and see if the planned network was able to communicate. This evaluation was never accomplished. However, the network plan was submitted to MITRE Corporation for scoring in order to determine the types of errors committed.

The net planning tasks during the IOA test seemed to be completed with greater expressed confidence in the outcomes than when the Army Net Managers worked alone. The resulting network initialization documents were more complete as each of the pairs of managers worked on the part of the problem each understood best (i.e., the Army Net Managers planned for the Army resources and the Air Force Net Managers for the Air Force resources). This approach seemed preferable to both pairs of managers and each learned some techniques from the other. The task was completed in four hours; however, more skills and techniques were brought to bear on the network plan.

MITRE scoring of the outcomes showed errors to be present which would have prevented the planned network from working. Even with the errors, it is difficult to say whether so complete a job could have been done by the Army or Air Force Net Managers separately, but it is doubtful. However, it seems from observation of the network planning task that the errors and lack of completion were not related to personnel concerns but to training emphasis, task complexity, and three weeks of non-related intervening activities.

Safety Design (IOA Issue 3.)

Deployment, Operation, and Maintenance

There were no JTIDS injury incidents during any of the pilot or multi-service test trials.

S250 Shelter Floor. Although not specifically a part of the JTIDS system, the S250 Shelter has one safety related problem. When wet, the floor of the shelter is very slippery. During the JTIDS IOA, all shelters were equipped with rubber mats to prevent the operators and maintainers from slipping and falling on wet floors during or after a rain.

Recommended Solution. Either coat the shelter floors with a slip resistant finish or equip each shelter with non-skid floor mats.

SECTION V SUMMARY

Introduction

Originally, the JTIDS test and evaluation was planned as a full scale Independent Operational Test and Evaluation (IOT&E), to be executed jointly with the Air Force. During the Army developmental testing, a number of problems were discovered in the Class 2 Terminal and it was not certified for transition to operational test. Since the multiservice testing between the Air Force and the Army was particularly important for the Air Force, the Army decided to support the Air Force to the minimal extent possible. This included the use of a single TSQ-73 and a single HAWK PCP, with four relays and minimal manning by the 11th ADA. The Army's portion of the test was downgraded to an Investigative Operational Assessment (IOA), lasting eight weeks.

The intent of this IOA was to ensure that the Army Class 2 terminals stayed operational during the multiservice trials, using every means at hand including maintenance personnel drawn from DT. Data collection was to be minimal, with low reliability due to the few trials and limited system operational time. The data collected was to be used to provide insights into the adequacy of the design of the Class 2 Terminal from the Army's perspective, and to provide input into the design of the Class 2M Terminal.

The objectives of this IOA for MANPRINT were to provide, to the degree possible, insights on how well the JTIDS Class 2 Terminal met the requirements of the MANPRINT program. The specific domains of MANPRINT that were assessed during the IOA included personnel, training, human factors engineering (HFE), and system safety. Manpower could not be assessed given the limited 11th ADA unit resources available for the IOA, and health hazards were assessed by developmental testing.

The maintenance objective of the IOA was to ensure that the terminals stayed operational during the multiservice trials. This was achieved using whatever means were at hand. This practice introduced some confounds into the maintainability data and made it all but impossible to assess the effect of some of the variables.

The size of the IOA player pool was small (n = 8 for operators, n = 2 for net managers, and n = 2 for maintainers), lowering statistical validity, increasing the risk of a nonstratified sample of personnel characteristics, and limiting the generalizability of the data to the population as a whole. However, every effort was made to derive information which was as reliable as possible in reaching the conclusions presented in this report.

Conclusions

IOA Issue 1

JTIDS Class 2 Terminal shall be designed so that representative personnel have the necessary skills and aptitudes to be trained to perform the critical tasks to the required field proficiency. In general, this issue was satisfied by the JTIDS Class 2 Terminal in the IOA with one exception, the JTIDS - host interface.

Criterion 1. Initialization, reinitialization, and operational procedures shall be simple enough to be learned, retained, and performed by representative MOS personnel.

The demographic data showed the operators and maintainers to be representative of personnel in the respective MOS groups. The range and average scores for the eight operators and the two maintainers were appropriate for their MOSs and the anticipated operator/maintainer MOSs for the deployment units (e.g., HAWK units). If anything, the samples for the IOA were slightly below average for the host system MOS averages.

Results of the training showed the operators and maintainers had the necessary skills and aptitudes to learn the material presented in the standard training setting. No MOS group had any consistent advantage in terms of training performance, instructor ratings, or field task performance.

All operators performed the initialization, reinitialization, and operational tasks equally well. The tasks were simple enough so that they could be learned, retained, and performed given the standard training and the on-the-job performance aids used in the IOA.

The only training problems were procedures not covered during the training; either because they were not developed or because the short training time did not allow their inclusion. The operators were able to learn procedures in the field as their experience accumulated and as new procedures evolved.

The design of the system produced difficult procedures in one area. The interface between the host system and the JTIDS terminals did not meet the criteria of providing simple operational procedures when host interface problems arose. There was no simple way of isolating an interface problem to the host data multiplexer, the interconnecting wiring, or the JTIDS Host Interface Unit (HIU). A problem occurred in this area almost daily and no simple procedure was ever developed to isolate the causes of the problems.

IOA Issue 2

Human Factors design for ease of operation and maintenance.

Criterion 1a. Initialize terminal within two hours. The design of the system, even with its problems was able to meet this criterion. During the tests involving initialization of the terminal, no operator took more than 45 minutes to initialize the terminal with 10 slot block assignments even when wearing NBC protective gloves and mask. During field operation; the Master Battalion JTIDS terminal, requiring 35 slot block assignments, was manually initialized in 1 hour and 15 minutes.

Criterion 1b. Place into operation or change initialization variables within three minutes. Once initialized any single intialization variable or a slot block's variables were easily changed within the required three minutes. The terminal was also easily placed into operation within three minutes; however, entering the network as a communicating terminal almost never occurred within three minutes. From the standpoint of operator tasks, this criterion is met; however, this does not include entering the net as a participant.

Criterion 2. JTIDS Class 2 hardware and software design shall facilitate operator task performance. This criterion is met for most operator tasks, with three major exceptions. First, the hardware design is deficient in facilitating operator performance when entering the net under conditions of marginal received radio signals and operating in an ECM environment. Second, the hardware and software do not facilitate operator performance under conditions of JTIDS - host interface problems. Fianlly, the hardware and software do not facilitiate operator performance when BIT is run under conditions of uncertainty and must be run more than twice to verify a failure condition. Before the JTIDS Class 2 terminal can be said to meet this criterion these three major shortcomings must be remedied.

Criterion 3. Net planner shall perform necessary planning and develop initialization sequences without error and within four hours 98% of the time. This criterion was not met during the IOA. The problem does not appear to be a personnel problem in the sense of aptitude or intelligence. The tasks facing a net planner are complex and are not easily learned in a two week period. The more the net planners performed their tasks the better they got; however, they were never able to plan an entire IOA network without errors. The training is, if anything, rushed. Many complex details are covered quickly because of the time constraints, this leads to incomplete learning and forgetting in the absence of practice. In order for this criterion to be met in the future, changes should be made to training time and the job performance aids (e.g., the forms and a handbook).

Criterion 4. The system shall be designed so that maintenance tasks can be easily performed and the system repaired within 0.25 manhours 75% of the time. It is difficult to assess whether or not this criterion could be met because of the maintenance philosophy employed

during the IOA. However, observation of the maintenance activities performed by soldiers indicates that it cannot be met. Many of the BIT took more than 15 minutes to run, not including the time to disconnect cables, remove units, replace boards or units, reconnect cables, rerun BIT, reinitialize the terminal, and return the terminal to operation. This is espically true when considering the difficulties in removing and connecting cables given all the cable clearence problems noted. In addition, limited accessability caused by the current rack mounting configuration of the units further impeded the maintenance process. In order for this criterion to be met in the future, significant changes to the equipment front panel designs and the equipment mounting configuration will be required.

IOA Issue 3

JTIDS Class 2 terminals shall be designed to be operated and maintained without risk of personal injury. There were no injury problems during the IOA.

Criterion 1. Soldiers must be able to operate, maintain, and deploy the JTIDS Class 2 terminal without danger of personal injury. The current equipment mounting configuration limits two person access for heavy lifts and poses the real possibility of personal injury even though none occurred. In addition, the slippery-when-wet shelter floor also represents the possibility for injury. Both these problems should be fixed if the JTIDS Class 2 terminal is to be fielded in the S-250 shelter.

APPENDIX A - DATA COLLECTION FORMS

JTIDS IOA

DEMOGRAPHIC QUESTIONNAIRE

1. Date:__ __ __ __ __ 2. Time:__ __ __ __
Y Y D D D H H M M

3. Player No:__________ 4. Player Name:______________________________

5. Position: (__)Net Manager (__)Operator (__)Org. Maint. (__)DS Maint.

(__)Data Collector (__)Test Directorate

6. Height:______ ______ 7. Weight:______ 8. Age:___ ___ ___ ___
Feet Inches Lbs. Years Months

9. SSN: ____________________________

10.Grde/Rank: ____________________ 11. Time in Service:___ ___ ___ ___
Years Months

12. Assigned Unit:____

13. Primary MOS:________________ 14. Time in Pri MOS:______ ______
15. Secondary MOS:________________ 16. Time in Sec MOS:______ ______
17. Duty MOS:________________ 18. Time in Dut MOS:______ ______

19. ETS Date: ___ ___ ___ ___ ___ ___
Y Y M M D D

20. How many months have you been working with the JTIDS:_________(months)

21. Please indicate the JTIDS training you had: Net Mgr Class ________
Opr - Org Class ________
DS Maint. Class ________
Class plus OJT ________
FTX in Florida ________

22. Date Training started _____ / _____
Mo Day

23. Civilian Education: (Please circle letter of highest achievement)

a. No High School Diploma
b. GED
c. High School Graduate
d. Trade School Graduate
e. 1-2 years of college
f. 3-4 years of College
g. College Graduate
h. Advanced Degree

24. Degree or Trade:______________________________

25. Other personal skills (e.g., computer programming, electronics, etc.):

____

____

____

26. Do you wear prescribed glasses or contacts ______: if yes, why?

____ Seeing close (reading) _____ Seeing far (driving)

Other:____________________________________

____

27. If you have ever had an eye injury, please explain:____________________

____

____

28. Have you ever had any hearing problems _____: if yes, explain:__________

____

____

29. Have you ever had any problems with your arms, legs, hands, neck, and/or torso which make it difficult for you to drive, lift/carry, walk/run, and/or perform other motor activities ________: if yes, explain:

____

____

____

30. Have you been sick in the past two weeks ________: if yes, explain______

____

____

31. If you are taking any prescribed medication, please name it and tell why you are taking it: ______________________________

____

____

____

Rev. 3, 26 Feb 87

JTIDS IOA

OPERATOR/MAINTAINER QUESTIONNAIRE

1. Name__________________________ 2. Rank__________________________

3. SSN___________________________ 4. MOS___________________________

5. Are you a JTIDS Operator______ DS Maintainer_______

6. Are you assigned to a Relay____ HAWK Fire Unit____ Battalion___

7. Have you experienced any difficulties in erecting either of the JTIDS Class 2 Terminal antennas?

	Yes	No
a. Shelter Mounted	_____	_____
b. External Antenna	_____	_____

If yes, please describe these difficulties:

8. Have you experienced any difficulties in attaching or removing the cables used to connect the JTIDS van with the generator or the HOST terminal?

Yes____ No____

If yes, please describe these difficulties:

9. Have you experienced any difficulties in attaching or removing the cables that connect the various JTIDS components?

Yes____ No____

If yes, please describe these difficulties:

10. Have you experienced any difficulties in installing or removing any of the following components:

	Yes	No
a. Battery:	____	____
b. Secure Data Unit (SDU):	____	____
c. Blower-Power Supply Unit:	____	____
d. Keyer Control Panel:	____	____
e. Other ________________:	____	____

If yes to any, please describe these difficulties:

11. Have you experienced any difficulties in understanding and performing the procedures for starting up the JTIDS terminal?

Yes____ No____

If yes, please describe these difficulties:

12. Have you experienced any difficulties in performing the initialization procedures for the JTIDS terminal?

Yes____ No____

If yes, please describe these difficulties:

13. If you have been interrupted during initialization, have you ever experienced any difficulty in determining where you left off and then completing the initialization?

Yes____ No____

If yes, please describe the difficulties and how they effected your ability to perform your mission:

14. Have you experienced any difficulties in using, when wearing standard uniforms, the controls on the JTIDS terminal equipment due to size, shape, distance between controls, force required to activate, or other reason?

Yes____ No____

If yes, please describe these difficulties:

15. Have you experienced any difficulties in using, while wearing MOPP IV or cold weather gear, the controls on the JTIDS terminal equipment due to size, shape, distance between controls, force required to activate, or other reason?

Yes____ No____

If yes, please describe these difficulties:

16. Have you experienced any difficulties in reading and understanding, while wearing standard uniforms, the labeling on the JTIDS terminal equipment due to size, contrast, terminology, abbreviations, or other reason?

Yes____ No____

If yes, please describe these difficulties:

17. Have you experienced any difficulties in reading and understanding, while wearing MOPP IV masks, the labeling on the JTIDS terminal equipment due to size, contrast, terminology, abbreviations, or other reason?

Yes____ No____

If yes, please describe these difficulties:

18. While wearing standard uniforms, have you experienced any difficulties in viewing, reading, or understanding the displays (LEDs, indicator lights, fault balls, etc.), especially on the interface control panel, due to size, color, contrast, letter shape, location, or other reason?

Yes____ No____

If yes, please describe these difficulties:

19. While wearing MOPP IV masks, have you experienced any difficulties in viewing, reading, or understanding the displays (LEDs, indicator lights, fault balls, etc.), especially on the interface control panel, due to size, color, contrast, letter shape, location, or other reason?

Yes____ No____

If yes, please describe these difficulties:

20. Does the JTIDS system always display understandable prompts when you have to input data or a command?

Yes____ No____

If no, please describe when the prompts are not adequate:

21. Are the menus used by the JTIDS Interface Control Panel displayed in a logical arrangement or order?

Yes____ No____

If no, please describe how it is not logical:

22. Are the terms, abbreviations, and codes used by the JTIDS system logical and consistent with what you expect?

Yes____ No____

If no, please describe how they are not logical:

23. Have you experienced any difficulty using the JTIDS terminal because of too much information being displayed at one time?

Yes____ No____

If yes, please describe:

24. Are the different menus and display pages on the ICP consistent in format with one another?

Yes____ No____

If no, please describe how they differ:

25. Do you get adequate and timely feedback from the JTIDS terminal that it has accepted a command or data?

Yes____ No____

If no, please describe how it is inadequate:

26. Do you have any difficulty understanding error messages and correcting the cause of the error?

Yes____ No____

If yes, please describe why:

27. When stepping through a series of menus, do you easily know where you are in the sequence?

Yes____ No____

If no, please describe:

28. When stepping through a series of menus, can you easily terminate an operation and get back to the beginning menu in the series?

Yes____ No____

If no, please explain:

29. Are the procedures for using the JTIDS terminal easy to understand and in logical order?

Yes____ No____

If no, please explain:

30. Are there steps in the data entry procedures that you consider unnecessary?

Yes____ No____

If yes, please describe them:

31. Have you experienced any difficulties in performing your tasks on the JTIDS terminal due to the workspace in the shelter?

Yes____ No____

If yes, please describe these difficulties:

32. Is the lighting in the JTIDS shelter adequate for reading the displays and manuals?

Yes____ No____

If no, please explain:

33. Did the training adequately prepare you to perform your assigned tasks with the JTIDS terminal, especially in a field operation?

Yes____ No____

If no, please describe weaknesses in the training and how it could be improved:

34. Do the technical manuals (TMs) provide clear, concise, understandable details on how to operate and maintain the JTIDS terminal?

Yes____ No____

If no, please explain why and how the TMs could be improved:

35. Given your observations during the OT of the JTIDS terminal, do you feel that your fellow operators and maintainers have the required skills for operation and maintenance of the system?

Yes____ No____

If no, please describe why:

36. Have you experienced any incidents of incorrect fault isolation of LRUS/SRUs using the JTIDS built-in-test (BIT)?

Yes____ No____

If yes, please describe:

37. Have you experienced any instances of the BIT indicating falsely that a SRU was acceptable?

Yes____ No____

If yes, please describe:

38. Have you experienced any difficulties in accessing and removing any SRUs for maintenance?

Yes____ No____

If yes, please describe:

39. Have you experienced any difficulty in using the troubleshooting procedures in the technical manuals to perform the BIT for fault isolation?

Yes____ No____

If yes, please describe these difficulties:

40. Have you experienced or observed any incidents where personnel were injured by sharp edges, electric shock, smashed fingers, etc. while operating or maintaining the JTIDS terminal?

Yes____ No____

If yes, please describe:

41. Please make any other comments or suggestions about the JTIDS terminal that you have not already covered:

JTIDS IOA

ICP INITIALIZATION CHECKLIST

Name________________________________ Date ________________ Time __________

SSN ________________________________ SJS ________________ Time __________

MOPP Level _____________ (0 - 4)

MENU	SELECTION	VALUE		CORR	REMARKS
DISPLAY	CONT				
CONT	RESET				
RESET	IRC				
CONT	FUNC				
FUNC	SNE N				
	RCDRON				
	POOLAB				
	TRANS				
PERFORM	STAND BY / ON				
CONT	PG1				
DISPL	MODES				
MODES	NORM				
NORM	REF				
	PRI				
DISPL	INIT				
INIT	MAN				
MAN	IPF				
IPF	EXER				
SDU VAR	#LOC 0	2/0			
	#LOC 1	2/1			
	#LOC 2	13/0			
	#LOC 3	13/1			
	#LOC 4	14/0			
	#LOC 5	14/1			
	#LOC 6	1/0			
	#LOC 7	1/1			

	<	
	TRANS	
COM-MODE	MODE 1	
MAN	DFLT	
DFLT	#NET	0
	#MSEC	1
	#TSEC	1
	TRANS	
MAN	SLOTS	
SLOTS	#BLK	1
	#SLOT	29C
	>	
SLOTS	#TSEC	2
	#MSEC	2
	#R-RATE	10
	>	
SLOTS	#NPG	3
	#NET	0
	COMN	
	TIME	
TSLOT	XMIT	
	#ACES	4
	<	
SLOTS	TRANS	
SLOTS	#BLK	2
	#SLOT	787A
	>	
SLOTS	#TSEC	13
	#MSEC	13
	#R-RATE	4
	>	
SLOTS	#NPG	28
	#NET	3
	COMN	
	TIME	
TSLOT	XMIT	
	#ACES	16
	<	
SLOTS	TRANS	

SLOTS	#BLK	3			
	#SLOT	15A			
	>				
SLOTS	#TSEC	13			
	#MSEC	13			
	#R-RATE	10			
	>				
SLOTS	#NPG	29			
	#NET	3			
	COMN				
	TIME				
TSLOT	XMIT				
	#ACES	16			
	<				
SLOTS	TRANS				
SLOTS	#BLK	4			
	#SLOT	5A			
	>				
SLOTS	#TSEC	14			
	#MSEC	14			
	#R-RATE	10			
	>				
SLOTS	#NPG	33			
	#NET	4			
	COMN				
	TIME				
TSLOT	XMIT				
	#ACES	16			
	<				
SLOTS	TRANS				
SLOTS	#BLK	5			
	#SLOT	7B			
	>				
SLOTS	#TSEC	2			
	#MSEC	2			
	#R-RATE	12			
	>				
SLOTS	#NPG	6			
	#NET	1			
	COMN				
	TIME				

TSLOT	RCV				
	#ACES	16			
	<				
SLOTS	TRANS				
SLOTS	#BLK	6			
	#SLOT	11B			
	>				
SLOTS	#TSEC	2			
	#MSEC	2			
	#R-RATE	11			
	>				
SLOTS	#NPG	6			
	#NET	1			
	COMN				
	TIME				
TSLOT	RCV				
	#ACES	16			
	<				
SLOTS	TRANS				
SLOTS	#BLK	7			
	#SLOT	27A			
	>				
SLOTS	#TSEC	13			
	#MSEC	13			
	#R-RATE	10			
	>				
SLOTS	#NPG	6			
	#NET	3			
	COMN				
	TIME				
TSLOT	RCV				
	#ACES	16			
	<				
SLOTS	TRANS				
SLOTS	#BLK	8			
	#SLOT	19A			
	>				

SLOTS	#TSEC	13			
	#MSEC	13			
	#R-RATE	10			
	>				
SLOTS	#NPG	28			
	#NET	3			
	COMN				
	TIME				
TSLOT	RCV				
	#ACES	16			
	<				
SLOTS	TRANS				
SLOTS	#BLK	9			
	#SLOT	8A			
	>				
SLOTS	#TSEC	14			
	#MSEC	14			
	#R-RATE	11			
	>				
SLOTS	#NPG	32			
	#NET	4			
	COMN				
	TIME				
TSLOT	RCV				
	#ACES	16			
	<				
SLOTS	TRANS				
SLOTS	#BLK	10			
	#SLOT	25A			
	>				
SLOTS	#TSEC	13			
	#MSEC	13			
	#R-RATE	10			
	>				
SLOTS	#NPG	6			
	#NET	2			
	COMN				
	TIME				
TSLOT	RCV				
	#ACES	16			
	<				
SLOTS	TRANS				

SLOTS	<				
MAN	POS				
POS	POS				
POS	LAT				
LAT	#LAT	N30/34/13.7			
	#LONG	W86/07/45.1			
	#HGT	145			
	>				
LAT	#PUNCR	20			
	#HUNCR	20			
	TRANS				
POS	<				
MAN	TN				
TN	#PRI	102			
	TRANS				
MAN	STA				
STATION	NETE				
NETE	NO				
STATION	CONFIG				
CONFIG	ANT A				
RCVRS	4				
STATION	CONN				
CONN	YES				
STATION	REPROM				
REPROM	OFF				
STATION	<				
MAN	TIME				
TIME	#IGMT	HR/MN/SC			
	ER/SEQ				

ER/SEQ	#ERROR	2/0
	TRANS	
MAN	PG1	
DISPL	BLT	
BLT-INIT	RCRDR	
RCRDR	#CONT1	F11C
	#CONT2	FF0B
	TRANS	
RCRDR	#CONT4	FFEC
	TRANS	
BLT-IN	PG1	
DISPL	CONT	
CONT	FUNC	
FUNC	ANT	
ANT	A	
CONT	FUNC	
FUNC	SNE Y	
	TRANS	
	PG1	
DISPL	INIT	
INIT	EOL	

HIU INITIALIZATION

CONFIG	ICP	
DISPL	HIU	
HIU MODE	INIT	
HIU INIT	RESET	
RESET	YES	
	TRANS	
HIU INIT	NI	

```
NETMG/    HAWK
          NCS              N
          TRANS

ATDL-1   #HSTADR           AH
          TRANS

DLRP     #LAT          N31/15/00.0
         #LONG         W85/25/00.0
          TRANS

CHAN     -CHNUM            1
TYP       ATOP
|
| ATDL-1   -CHNUM            1
| 1/2      #DEST             A
|          #NPG              33
|          #RR               10
|          #CNTRLR           N
|
| ATDL-1   -CHNUM            1
| 2/2        VNR NA
|
CH TYP    END

MSG CNTR P2DP
         #SIMF             N
         #HCNT             7
          TRANS

GEO FLT   NO
          TRANS

TSRD     #DATCAT           0000
          TRANS

HIU IN    EOL
          PG1
```

JTIDS IOA
TASK PERFORMANCE ERROR REPORT

Date:____________ Time:________________

Oper/Maint:__________________________ SSN:________________

Senario Number:______________________ Terminal ID:________________

Environment:

Uniform: Normal ___ NBC ___ COLD ___

Jamming: No ___ Yes ___

Start Time ________ Stop Time __________ Total Time _________

Type of Action:

Normal Operation _____ JTIDS Initialization _____ Fault Iso/Repair _____

Install/move/pwr _____ Place into Operation _____ J Gram message _____

!! TASK TYPE (circle) !!

INSTALL/MOVEMENT : JTIDS INITIALIZATION : FAULT ISO/REPAIR : J GRAM MESSAGES

NORMAL OPERATION:
When Host operator problem -

Description of Incident:

	Friendly Tracks	Enemy Tracks
Tracks on Host Monitor	____________	____________

Track filtering in use (if any):

OTHER ACTION TYPES:

Describe Each Observed Error (Use back of page, if necessary):

Total Number of Errors:________

Additional Comments:

Data Collector:________________________________ SSN: ____________________

JTIDS IOA
SAFETY INCIDENT REPORT

Date of the incident:____________ Time of the incident:____________

Equipment Involved in the Incident:

___ Shelter
___ Antenna Assembly
___ Interface Control Unit
___ Host Interface Unit
___ Radio Receiver/Transmitter
___ Battery
___ Digital Data Group Processor
___ Keyer Control Panel
___ Other, ____

Personnel involved in the incident:

Oper: ___ SSN: ______________ Maint: ___ SSN: ______________

Other: ___ SSN: ______________

Location of the incident (site, location at the site, etc.):

Describe the nature of the injury:

What was the Cause of the injury:

Please describe the incident in detail:

How could the incident be prevented?

Name of person completing this form:

Signature: